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PRELIMINARY OPTIONS FOR METHODOLOGIES TO APPLY ADJUSTMENTS UNDER ARTICLE 5.2 OF THE KYOTO PROTOCOL

Technical paper

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CONTENTS

		Paragraphs	Page
I.	INTRODUCTION	1 - 13	3
	A. Mandate	1 - 5	3
	B. Scope	6 - 11	4
	C. Possible action by the SBSTA	12 - 13	5
II.	PRELIMINARY FINDINGS OF THE CONSULTANTS	14 - 25	6
	A. Findings relevant to specific methods	15 - 24	6
	B. Findings relevant to specific sectors	25	8
III.	PRELIMINARY CONCLUSIONS	26 - 27	8
	Annex: List of expert reports		15

I. INTRODUCTION

A. Mandate

1. Article 5.1 of the Kyoto Protocol states that guidelines for national systems, which shall incorporate the methodologies specified in Article 5.2, shall be decided upon by the Conference of the Parties (COP) serving as the meeting of the Parties to the Protocol at its first session.

2. Article 5.2 of the Kyoto Protocol states that methodologies for estimating anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol shall be those accepted by the Intergovernmental Panel on Climate Change (IPCC) and agreed upon by the Conference of the Parties at its third session. Where such methodologies are not used, appropriate adjustments shall be applied according to methodologies agreed upon by the Conference of the Parties serving as the meeting of the Parties to the Protocol at its first session.

3. The Subsidiary Body for Scientific and Technological Advice (SBSTA), at its eleventh session, recalled Article 5.2 of the Kyoto Protocol and took note of submissions by Parties on the issue of adjustments. It considered that adjustments referred to in this Article should only be applied when inventory data submitted by Parties are incomplete and/or are calculated in a way that is not consistent with the Revised 1996 IPCC Guidelines as elaborated by any good practice agreed upon by the COP. It noted that these adjustments would result in substitution of a revised technical estimate for the purpose of accounting of the Parties' emissions and assigned amounts. It also considered that adjustments related to Article 5.2 could be an element of the review process under Article 8 of the Kyoto Protocol. The methodologies and procedures of adjustments, including the question of who should apply these adjustments, should be further examined in the preparatory work related to Articles 5 and 8 of the Kyoto Protocol (FCCC/SBSTA/1999/14, para. 51 (i)).

4. At the same session, the SBSTA requested the secretariat to prepare documentation for consideration at the workshop on Articles 5, 7 and 8, to be held 14 to 16 March 2000 in Bonn, on preliminary options for methodologies to apply adjustments (FCCC/SBSTA/1999/14, para. 51 (c)).

5. The SBSTA also requested the secretariat to provide an initial draft on modalities for adjustments under Article 5.2, taking into consideration information from the workshop, for consideration by the SBSTA at its twelfth session (FCCC/SBSTA/1999/14, para. 51 (d)).

B. Scope

6. This technical paper supplements information provided in document FCCC/SBSTA/2000/INF.5/Add.2. It presents options for methodologies to apply adjustments in response to the above mandate[1]. It focuses on methodologies to obtain revised technical estimates of emissions. The preliminary information contained herein is based on a limited number of countries and sources. This working paper summarizes the main findings of reports prepared by consultants for the secretariat. The full reports of the consultants on the IPCC source categories "fuel combustion activities"[2], "fugitive emissions from fuels", "industrial processes", "agriculture" and "waste" are available as working papers 3 (a) to 3 (g) (2000) (see also annex)[3]. These reports do not necessarily reflect the views of the secretariat. The responsibility for the text remains with the authors.

7. The reports by the consultants may also provide useful background information relevant to the technical review of inventories and may be considered in the development of technical guidance for such a review.

8. The experts were instructed to search for methods to obtain revised technical estimates of emissions that:

(a) Can be performed objectively without assumptions, i.e. being independent of the person performing the estimation and ensuring transparency; and

(b) Are based on readily available data from Parties or other authoritative sources, e.g. IPCC default emission factors, or international statistics.[4]

9. Several approaches could be used to calculate adjustments, including problem-independent approaches, which could be used regardless of the identified problem, and problem-specific approaches, which would take into account the identified problem. To decrease the complexity of the task in the limited time-frame given, the consultants were requested to place emphasis on problem-independent approaches, based on the assumption that these would be simple, replicable and more transparent than problem-specific approaches. The emission

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[1] This paper is a revision of the working paper No. 3 (2000), which was made available at the workshop on issues related to Articles 5, 7 and 8.

[2] The work on the category "fuel combustion activities" was split between three consultants. One worked on the estimation of CO_2 emissions according to the IPCC categories based on available international energy data, the second worked on the split of fuel use according to IPCC sectors, CO_2 emissions per capita as well as CH_4 and N_2O emissions, while the third worked on interpolation, extrapolation and approximation using drivers.

[3] These papers can be obtained from the secretariat upon request or from the UNFCCC web site at http://www.unfccc.de/sessions/workshop/000314/

[4] The consideration of the "conservativeness" of these revised technical estimates was not within the scope of this work.

estimates obtained would fill the gaps or substitute the estimates in question. Where problem-independent approaches were not possible, problem-specific solutions were to be presented.

10. The consultants were instructed to consider at least the following methods, the selection of methods being based on the preliminary views of Parties at the point of initiation of this project (FCCC/SBSTA/1999/MISC.9 and Add.1):

(a) Calculation of source emissions according to IPCC tier 1 methods using data from external sources (activity data, emission factors);

(b) Estimation of emissions based on averages over countries included in Annex B to the Kyoto Protocol. The average emission rate of several Parties would be applied to an emission driver of one Party such as gross domestic product (GDP), population etc;

(c) Estimation of emissions of one gas or source category based on the linkage to emissions of another gas or source category. This could be the case, for example, where the same activity data are usually used to calculate the emissions of several gases or categories;

(d) Extrapolation of emissions according to a defined methodology based on the linkage of emissions with a driving indicator or growth factor;

(e) Linear or other simple interpolation and extrapolation.[5]

11. The consultants had access to the greenhouse gas emissions database of the UNFCCC and further detailed inventories of selected countries. They were also provided with access to other international data sources. The experts were instructed to collect any additional data necessary to perform the estimates, including data on drivers. The estimation according to these methods was to be performed and compared with estimates reported by Parties to judge their reliability, accuracy and comparability.

C. Possible action by the SBSTA

12. Parties may wish to take the information in this paper into account when considering issues related to methodologies and to the process of adjustments under Article 5.2 of the Kyoto Protocol as described in document FCCC/SBSTA/2000/INF.5/Add.2.

13. Parties may also wish to consider this paper and the reports by the consultants with a view to determining whether any additional analysis is needed and the time-frame for such analysis. If further analysis is deemed necessary, participants may wish to consider who should undertake such work, including possibly the National Greenhouse Gas Inventories Programme of the IPCC.

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[5] Interpolation and extrapolation with and without drivers is covered by the IPCC good practice report. It was included here to be tested throughout the sectors with available data.

II. PRELIMINARY FINDINGS OF THE CONSULTANTS

14. The findings presented below were obtained by the consultants following guidance by the secretariat. This is described in paragraphs 8 to 11. These findings generally refer to problem-independent approaches.

A. Findings relevant to specific methods

Interpolation

15. This method is applicable for the cases where emission estimates of the adjacent years are available. It is the only method where the emission estimate can be calculated objectively without the use of assumptions.

Extrapolation

16. If emissions estimates are available for some years, the missing estimates could be extrapolated. The results depend on the type of extrapolation chosen, for example linear or polynomial and also the number of existing emission estimates considered. The difference between the estimates extrapolated for one year and those reported by Parties for that year was found to be up to 10 per cent, reflecting the year-to-year fluctuation of the estimates in some source categories.[6]

Extrapolation using drivers

17. If the estimates are available for one year, for most sectors these could be extrapolated for other years using an index of the driving force. Detailed analysis of the relationship between emissions estimates and drivers can be found in the individual consultants' report. The difference between the estimates obtained using drivers and those reported by Parties was found to be about 5 to 15 per cent. This method is generally more accurate for higher levels of aggregation, i.e. the first and second level of IPCC source categories. However, it is not likely that methods could be developed into guidelines valid for all countries, emissions and time periods, so that assumptions would not have to be made. Therefore, experienced personnel may have to perform the estimation. In some situations it may be more time consuming to find significant relations between the driver and the emissions, than to calculate the emissions using IPCC methods.

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[6] Differences reported in this paragraph and those below reflect analysis based on data from a limited number of Parties which in most cases have not undergone a technical review. The differences should only be considered indicative.

IPCC tier 1 methods

18. For most emission source categories, international activity data and IPCC default emission factors are available to estimate emissions according to the simplest IPCC method (tier 1). However, these emission estimates depend on the quality of the activity data used and whether the default emission factors reflect the national circumstances of that country. The quality of the international activity data varies for sectors and countries. Default emission factors are in most cases given as ranges. For many sectors, additional assumptions have to be made.

19. Therefore, the level of agreement between estimates reported by Parties and estimates obtained by the consultants using defaults varies between sectors. For fuel combustion activities, a method was developed to obtain CO_2 emissions split into IPCC sectors based on international energy data. The total emissions from fuel combustion estimated using this approach were around 5 per cent different to those reported by Parties. Emissions from agriculture for the tested examples using international activity data and default emission factors differed by a factor of 2 to 10 from the values reported by Parties.

Estimation of emissions based on Annex I averages

20. Estimation of emissions based on averages over countries included in Annex I to the Kyoto Protocol could be applied. This method does not take national circumstances into account. It may be possible to group countries with similar circumstances into clusters so that the average better reflects the situation in the country. In the selection of the cluster composition, assumptions may have to be made. The composition of the clusters would need to be considered on a source category basis.

21. One possibility would be to use average Annex I emission factors in place of IPCC default values in IPCC tier 1 methods. The values would, however, be very similar. One possible advantage would be that one less assumption would have to be made, if defaults are given as ranges.

22. Care needs to be taken in implementing this approach, because the condition that national circumstances are similar does not often apply. CO_2 emissions per capita or per GDP is an obvious example. Also for fugitive emissions from fuels, emission factors may vary dramatically between countries depending on the design and operating practice, types of oil and gas activity, age of equipment, and environmental regulation. The same applies to the waste category, if one Party is phasing out landfilling in favour of composting and incineration, and one is using landfilling as the major option. Agricultural emissions are highly dependent on the national circumstances and practices.

23. The difference between emissions estimated using Annex I averages and those reported by Parties ranged from 10 per cent to a factor of 2 for the selected source categories.

Linkage of emissions between gases or source categories

24. Estimation of emissions of one gas or source category based on the linkage to emissions of another gas or source category can only be applied in a limited number of cases. For fuel combustion activities, CH_4 and N_2O can be calculated from CO_2 emissions; the results are similar to using IPCC default emission factors. For some agricultural sources the ratio between nitrogen and carbon contained in the residue is part of the IPCC tier 1 method. A link between the CH_4 emissions and N_2O emissions from manure management systems in terms of a ratio cannot be made since emissions of those gases depend on different factors. However, in certain circumstances an increase in emissions of one gas would result in an increase in the other.

B. Findings relevant to specific sectors

25. The table below (pp.10 - 14) provides an overview of the sector-specific findings of the experts.

III. PRELIMINARY CONCLUSIONS

26. The following preliminary conclusions can be drawn from the work of the consultants:

(a) Potential conflict may exist between goals such as transparency, replicability, simplicity and accuracy with respect to methods to apply adjustments. Additional technical work would be required to better describe an optimal balance between these goals. This work would be aided by the information from the Parties regarding the priority to be placed on various goals;

(b) For problem-independent approaches, methods which are transparent, replicable, simple and can be applied without using assumptions were not identified, except interpolation. Generic approaches that can be applied regardless of the type of problem, may have limited applicability;

(c) For problem-specific approaches, a complex set of methods for problems involving all gases, sectors and countries would have to be developed in order to achieve accurate results without the use of assumptions;

(d) The development of emission estimates may benefit from the experience of experts of the Party;

(e) Developing accurate adjustments relating to problems in some sectors, gases and countries may require experienced experts using a case by case approach. This would include making specific assumptions and taking into consideration information provided by the concerned Party. Guidance on how to choose the appropriate methods and assumptions may be needed;[7]

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[7] The IPCC National Greenhouse Gas Inventories Programme will develop an emission factor database, which could be of value in this regard.

(f) Every effort should be made during the review process to correct identified problems before a decision on the need for an adjustment is taken. This would reduce the number of adjustments and make the adjustment process more manageable as well as faster.[8]

27. Further analysis may be necessary in order to draw conclusions on the matter, including analysis of problem-specific methods in the different sectors.

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[8] Assessment of the time required to calculate a revised technical estimate was not within the scope of this paper. However, it may be a relevant element in the design of the adjustment process. See also figure 1 in document FCCC/SBSTA/2000/INF.5/Add.2

FINDINGS OF THE EXPERTS RELEVANT TO SPECIFIC SECTORS

(Note that the sample size of countries examined was limited in most cases. See specific reports of the consultants for details. The differences to the estimates reported by Parties should only be considered indicative.)

Sector	Source	Gas	Tier 1 IPCC method			Estimation based on Annex I average		Extrapolation using drivers		Comments
			Default emission factors available?	All necessary activity data available from international sources?	Difference to the estimates reported by Parties	Index	Difference to the estimates reported by Parties	Index	Difference to the estimates reported by Parties	
1A Energy, fuel combustion activities	Total	CO_2	Yes, per fuel	Yes (quality depending on country)	Around ± 5%	Average per capita emissions if grouped in clusters	± 15%	GDP	±few % (inside)[9] ±15% (outside)	- If international energy data are available, they are usually reported and already used by the Party. - Differences to national estimates are due to differences in energy data used and allocation to sectors
	Total	CH_4 / N_2O	Yes, per technology	Fuel consumption available but not combustion technology	Factor of 2	Average emission factors same as default emission factors		Fuel consumption	± 5%	- Emission factors are technology dependent
	Sectoral breakdown (Energy Industries, manufacturing industries and construction, transport, other sectors)	CO_2	Yes, per fuel	Breakdown not available for all countries	Less accurate than total fuel combustion, up to ±15%	Split of total fuel use into sectors based on Annex I averages possible	Difference not assessed	Electricity production Industry: IEA industry indicator Residential: Population	±5% (inside), ±15% (outside) ± 20% a few % (inside) ±15% (outside)	- Total fuel consumption is more accurate than sectoral breakdown. However to calculate CH_4 and N_2O emissions, sectoral breakdown would provide for more accurate emissions

[9] 'Inside' refers to the situation where emission estimates of the two adjacent years are available. 'Outside' refers to the situation where emission estimates are only available for one adjacent year.

Sector	Source	Gas	Tier 1 IPCC method			Estimation based on Annex I average		Extrapolation using drivers		Comments
			Default emission factors available?	All necessary activity data available from international sources?	Difference to the estimates reported by Parties	Index	Difference to the estimates reported by Parties	Index	Difference to the estimates reported by Parties	
1B Energy, fugitive emissions	Solid fuels	CH_4	Yes, range for surface and range for underground mining	Ratio between underground and surface mining not available	Not quantitatively assessed	Emission factors may vary dramatically between countries.	Not quantitatively assessed	Coal production	Not quantitatively assessed	- Emissions are very country specific and depend on mine and operating practice
	Oil and natural gas	CH_4	For infrastructure and equipment	Data on infrastructure and equipment not available	Not quantitatively assessed	Emission factors may vary dramatically between countries. Metres of pipeline per capita may provide upper limit.		Oil and gas production	Not quantitatively assessed	- Emissions are very country specific and depend on design and operating practice, types of oil and gas activity, age of equipment, environmental regulation
2 Industrial processes	2A Mineral products	CO_2	Yes	A number of sources report industrial production data	Up to 20%	Cement production and Annex I average emission factor Industry value added	Up to 14% Up to factor 2	Industry value added	Up to 10%	- Only cement production considered
	2B Chemical industry	CO_2	Yes	A number of sources report industrial production data	Up to 15%	Ammonia production and Annex I average emission factor Industry value added	Up to 15% Up to factor 2	Industry value added	A few per cent	- Only ammonia production considered

Sector	Source	Gas	Tier 1 IPCC method			Estimation based on Annex I average		Extrapolation using drivers		Comments
			Default emission factors available?	**All necessary activity data available from international sources?**	**Difference to the estimates reported by Parties**	**Index**	**Difference to the estimates reported by Parties**	**Index**	**Difference to the estimates reported by Parties**	
	2C Metal production	CO_2	Yes	A number of sources report industrial production data	Up to 30%	Aluminium production and Annex I average emission factor Industry value added	Up to 30% Up to factor 6	Industry value added	Up to 20%	- Only aluminum production considered
	2D other production		Not considered							
	2E Production of halocarbons and SF6		Not considered							
	2F Consumption of halocarbons and SF6		Not considered							
4 Agriculture	4A Enteric fermentation	CH_4	Yes, up to 80% different to national factors	Animal population from the Food and Agriculture Organization (FAO). Does not separate dairy and non-dairy cattle	Around ±30%	Animal population, Annex I average emission factor - per livestock - per livestock unit	 Around 20% Up to 10%	Exponential growth rate of animal population	10%	--

Sector	Source	Gas	Tier 1 IPCC method			Estimation based on Annex I average		Extrapolation using drivers		Comments
			Default emission factors available?	All necessary activity data available from international sources?	Difference to the estimates reported by Parties	Index	Difference to the estimates reported by Parties	Index	Difference to the estimates reported by Parties	
	4B Manure management	CH_4	Yes, not country specific	Animal population from FAO. Does not separate dairy and non-dairy cattle	Factor 2 to 10	Animal population, Annex I average emission factor per livestock	--	Animal population	A few per cent	Emission factors are highly dependant on the national circumstances and practices and are reported as being uncertain
	4B Manure management	N_2O	Yes, not country specific	Animal population from FAO. Does not separate dairy and non-dairy cattle	Factor of 7	Animal population, Annex I average emission factor per livestock	Factor 2	Animal population	5%	--
	4C Rice cultivation	CH_4	Yes, not for all countries	Harvested rice area from FAO	50%	Harvested rice area and average Annex I emission factor	Factor 2	Harvested rice area	10%	Emission factors depend on a country's various water regimes and fertilizer characteristics
	4D Agricultural soils	N_2O	Yes	Fertilizer input, livestock, crop production, cultivated area from FAO	50%	Fertilizer input, Annex I average emission factor	Factor 2	linear relation between nitrogen input and emissions	A few per cent	Emissions depend on different fertilizer application method
	4E Prescribed burning of savanna	CH_4 and N_2O	Yes	Area of savanna burned not available	--	No published index found	--	No published index found	--	--

Sector	Source	Gas	Tier 1 IPCC method			Estimation based on Annex I average		Extrapolation using drivers		Comments
			Default emission factors available?	All necessary activity data available from international sources?	Difference to the estimates reported by Parties	Index	Difference to the estimates reported by Parties	Index	Difference to the estimates reported by Parties	
	4F Field burning of agricultural residues	CH_4 and N_2O	Yes	Fraction burned on the field may not be available, crop production from FAO	Total: factor 2, individual crop: factor 10	No published index found	–	Crop production	Not performed	–
6 Waste	6A Solid waste disposal on land	CH_4	Yes, not for all countries	Degradable organic fraction not available for all countries, methane correction factor and amount of recovered methane not available	Using assumptions within the certainty of the estimate which is 50%	Average default values of similar countries	Using assump-tions within the certainty of the estimate which is 50%	GDP/capita	50%	Solid waste disposal/treatment practices are economically and policy driven and can vary strongly from one country to another. For example, the Netherlands is phasing out landfilling in favour of composting and incineration, whereas the United Kingdom views landfilling as the best option.
	6B Wastewater handling	CH_4	Methodology to be further elaborated by good practice guidance			Not performed	--	Considered difficult	--	Wastewater disposal/treatment practices are economically, culturally, and policy driven and can vary strongly between countries.
	6C Waste incineration	CO_2	Not considered							--

Annex

LIST OF EXPERT REPORTS

Symbol	Title
Working paper 3 (a) (2000)	Fuel combustion activities: Sectoral breakdown of emissions based on international energy data
Working paper 3 (b) (2000)	Fuel combustion activities: Breakdown of aggregated fuel data, estimating CO_2 emissions from per capita emissions, CH_4 and N_2O emissions from fuel combustion
Working paper 3 (c) (2000)	Fuel combustion activities: Interpolation, extrapolation and approximation using drivers
Working paper 3 (d) (2000)	Fugitive emissions from fuels
Working paper 3 (e) (2000)	Industrial processes
Working paper 3 (f) (2000)	Agriculture
Working paper 3 (g) (2000)	Waste

These papers can be obtained from the secretariat upon request or from the UNFCCC web site at http://www.unfccc.de/sessions/workshop/000314/.

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